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INVESTIGATIONS WITH MALEIC HYDRAZIDE ON POTATOES I. EFFECT OF TIME OF APPLICATION AND CONCENTRATION UPON POTATO PERFORMANCE[1]

HERMAN TIMM, J. C. BISHOP, AND B. J. HOYLE[2]

The sprout-inhibiting property of maleic hydrazide has been demonstrated by Kennedy and Smith (5,6), Rao and Wittwer (8), and others (2,3,4,11). Optimum effects apparently occur when the chemical is applied to the foliage approximately two to six weeks before cessation of top growth (6,7). Reduction in yield (8) and development of aerial tubers (2) may result if application is made at bloom or earlier.

Maleic hydrazide has been used to a very limited extent in potato culture in California, since most of the crop is destined for fresh market distribution immediately after harvest and only a relatively small acreage in comparison is held in storage. In addition, trial spray applications have not always satisfactorily inhibited the sprouting of stored potatoes (10). Potato growers and processors however, have expressed a growing interest in the development of a chemical sprout-inhibitor that would reduce potato storage losses.

Two types of storage conditions exist in California. In the northern part of the state, potatoes are stored in prepared cellars for three to six months. In the southern areas they may remain in the soil for the same period of time after the tops have died down. Soil storage is feasible in areas where the soil temperature remains above freezing. If the crop is held in the soil or in cellars too long into the spring, excess sprouting is likely to occur.

This study was undertaken to determine the value of maleic hydrazide[3] as a sprout-inhibitor under California conditions.

METHODS AND MATERIAL

Two locations were selected as representative of the potato-producing areas of the state: Tulelake, Siskiyou County, for the northern and Shafter,[4] Kern County, for the southern part. Table 1 lists some of the cultural practices followed at the trial sites.

Foliar sprays of maleic hydrazide (MH-40) were applied to five varieties of potatoes: White Rose, Russet Burbank, Kennebec, Redkote and Pontiac in 1956. The chemical was sprayed to run-off on actively growing plants with a hand sprayer. Six spray treatments were given: 0, 1000, 2000, 3000, 4000, and 6000 ppm. Each treatment was replicated 3 or 4 times in a randomized block design. Treatment rows were 25 feet long, spaced 32 inches apart at Shafter and 36 inches apart at Tulelake. At

[1]Accepted for publication July 15, 1958.

[2]Assistant Olericulturist, Associate Vegetable Crops Specialist, Department of Vegetable Crops, and Associate Specialist in Field Station Administration, respectively, University of California, Davis, Calif.

[3]The water-soluble sodium salt of 1,2-dihydropyridazine-3,6-dione (MH-40) was supplied by U. S. Rubber Co., Naugatuck Chemical, Naugatuck, Connecticut.

[4]The authors wish to thank the U. S. Cotton Field Station Administration, Shafter, California, for supplying aid and land for this study.

TABLE 1.—*Some of the cultural practices applied to potatoes during field trials dealing with foliar applications of maleic hydrazide, 1956.*

Location of trial	Soil Type	Pounds Fertilizer 16-20-0 Banded/ Acre	Seed piece		Date	
			Depth Planted	Spacing in Row	Planted	Harvested
			(in.)	(in.)		
U.S.D.A. Cotton Experiment Station, Shafter, Kern County	Hesperia sandy loam	750	4	12	Feb. 17	June 6-7
U.C. Experiment Station, Tulelake, Siskiyou County	High organic	450	4	10	May 27	Oct. 20

Shafter plants were sprayed at two growth stages — 85-90 days and 95-100 days after planting, that is 3 and 2 weeks, respectively, before harvest — and at Tulelake sprays were applied 95-100 days after planting, approximately 3 weeks before death of tops.

Under the relatively dry and frequent hot periods during spring in Kern County, potato plants rarely flower. The Tulelake area is subjected to as many as three frosts during the growing season. Frosts are of such intensity that portions of the potato plant, or even the whole plant, die down to ground level. Under these circumstances flowering may be erratic.

Since the period of flowering could not be used as a reference for the time of application, spraying was scheduled for a certain number of days after planting.

At harvest, yield and specific gravity of tubers were recorded. Three replicates of randomly selected 10 to 25 pound samples of tubers from each spray date and concentration treatment were stored at two temperatures, 45°-55° F. (common) and 68° F. (controlled). At the end of six months, sprout weight and weight loss of tubers, together with notes on their general appearance before and after cooking, were recorded.

In the subsequent discussion, the terms "treated" and "untreated" tubers refer to tubers harvested from either treated or untreated plants. No tubers were treated with MH-40 after harvest.

RESULTS

Tuber Yields and Specific Gravity. No significant difference in yield or specific gravity of tubers resulted from the use of maleic hydrazide. Table 2 shows the response to applications of maleic hydrazide of White Rose grown at Shafter which was typical of results produced on the other varieties at both trial sites.

Sprouting. With potatoes stored at 68° F., date of spray application had little effect on sprout inhibition (Figure 1).

As the spray concentration was increased from 0 to 6000 ppm, sprouting decreased correspondingly, with greatest inhibition occurring at the 4000 to 6000 ppm level. Sprout inhibition was least variable with the early spray treatment. In general, the 3000-ppm level of MH-40 was as effective as the higher concentrations.

TABLE 2.—*Effect of date of spraying and concentration of maleic hydrazide upon yield and specific gravity of White Rose grown at Shafter.**

Spray Date	MH-40 Applied	Total Yield (Cwt Sacks/A)	Specific Gravity
	(ppm)		
3 Weeks before Harvest (85-90 days after planting)	Check	323	1.089
	1000	383	1.091
	2000	376	1.086
	3000	356	1.086
	4000	381	1.089
	6000	354	1.088
2 Weeks before Harvest (95-100 days after planting)	Check	369	1.084
	1000	378	1.089
	2000	397	1.083
	3000	337	1.086
	4000	354	1.087
	6000	346	1.083

*Differences for significance at 5 per cent level were not found.

All untreated tubers sprouted profusely. Tubers stored at 68° F. showed more evidence of apical dominance than those stored at 45°-55° F. Eyes at the apical ends of treated tubers showed greater inhibition of sprouting than those at stem ends of potatoes which received spray containing 1000 ppm of MH-40. With higher concentrations this variability in sprouting diminished.

Results obtained from the Tulelake trial were similar to those found at Shafter (Figure 2).

Tuber-weight Loss in Storage. Figure 3 shows typical sprouting of tubers after six months of storage. With Shafter-grown potatoes, held at 45°-55° and 68° F. storage, the per cent tuber weight loss decreased as MH-40 concentration increased (Figure 4). However, the loss in weight of tubers stored at 68° F., regardless of spray treatment, was approximately double that of those stored at 45°-55° F. Time of spray application did not influence the per cent tuber weight-loss at a given storage temperature. The least loss in weight was noted with 3000 to 6000 ppm concentrations.

In table 3, a comparison is made between the White Rose and Kennebec varieties, which emphasizes the differential response of varieties to MH-40 under field conditions.

Weight-loss of tubers stored at 45°-55° F., from the Tulelake trial, was not affected by MH-40 sprays (Figure 5). At 68° F. storage the weight loss of treated tubers was half that of untreated tubers. MH-40 spray concentrations above 1000 ppm did not materially alter tuber weight loss at the higher storage temperature.

Chipping and Cooking Quality. No discernible change in chipping quality could be attributed to the use of MH-40. Neither could any apparent differences in cooking quality within a variety be detected on the basis of color, mealiness, or taste.

DISCUSSION

The greater inhibition of sprouting and reduced weight loss of tubers from plants sprayed three weeks, as compared with two weeks, before

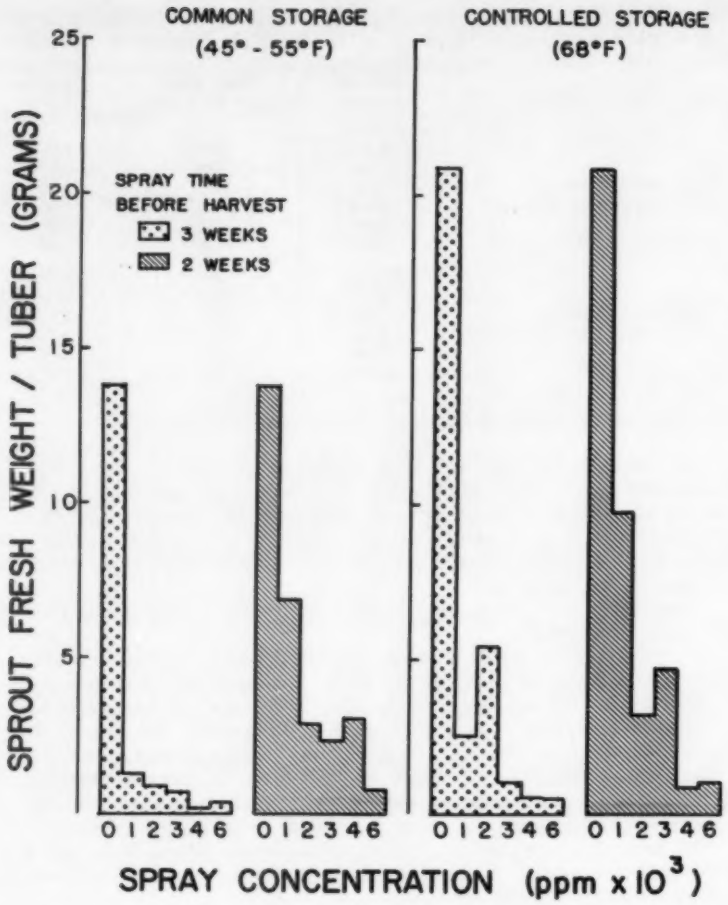

FIGURE 1.—Effect of time of application and concentration of MH-40 on the sprout development of Shafter-treated potatoes after six months' storage.

harvest, suggests that MH-40 penetrated the foliage slowly. Recent studies by Smith *et al.* (9) have indicated that foliar absorption of maleic hydrazide is relatively slow and is dependent upon temperature, relative humidity, and spray concentration. High temperatures and low humidity lower the turgidity of leaf cells and thus reduce the rate of penetration. Once within the leaf, however, the chemical is apparently translocated freely (1).

In the Kern County potato-growing area, day air temperatures increased markedly from a mean of 80° to extremes of 95° and 110° F. during late May and early June. The presence of blackheart in many Kennebec

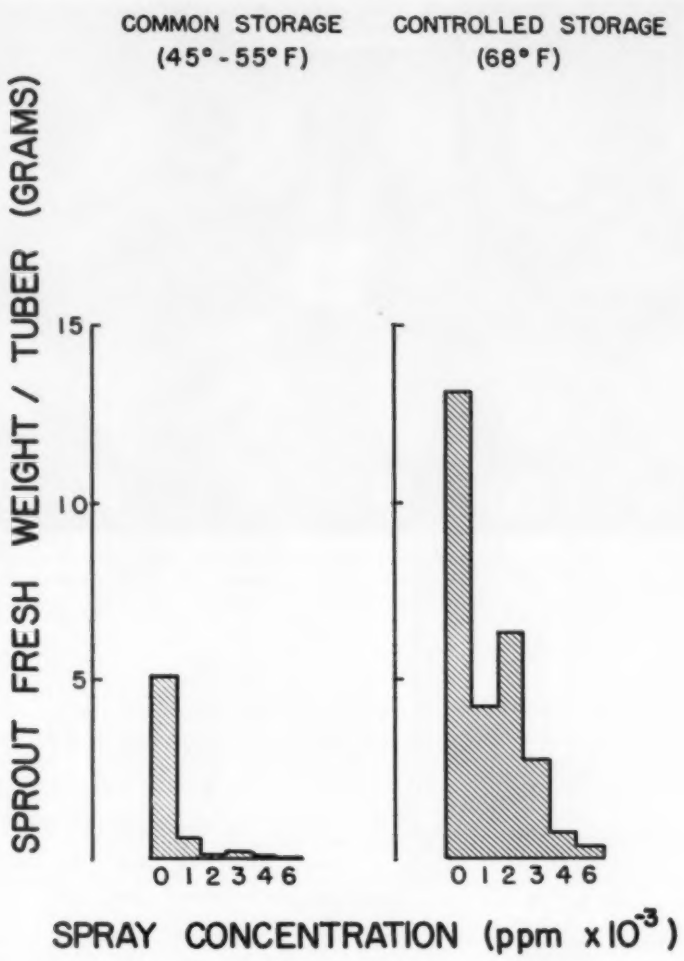

FIGURE 2.—Effect of MH-40 on the sprout development of Tulelake-treated potatoes after six months' storage.

tubers indicated excessive respiration due to increasing soil temperatures between curtailment of irrigation and harvest, a period of six days.

This climatic effect on the rate of MH-40 penetration, along with a change in tuber respiration, may provide a partial explanation for inconsistencies in results of earlier trials and in this study in which White Rose and Kennebec responses were compared (Table 3). In contrast, tubers

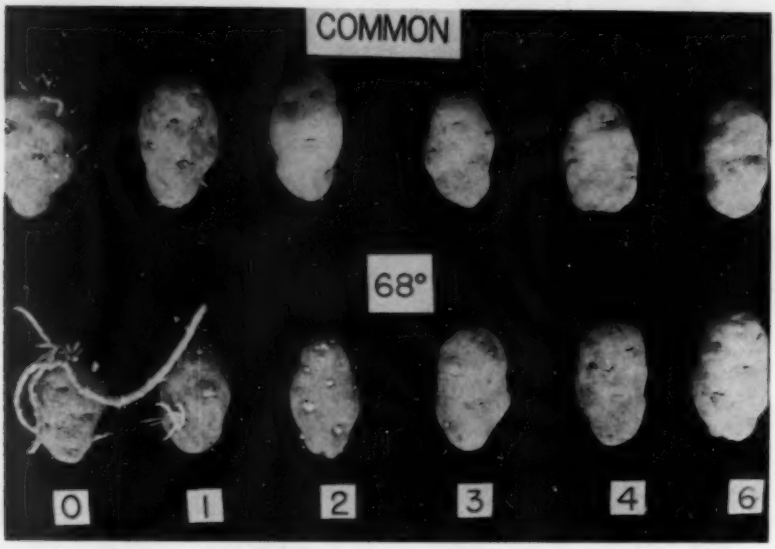

FIGURE 3.—Typical sprouting of White Rose potatoes from plants sprayed with 0, 1, 2, 3, 4, and 6 × 10^3 ppm of MH-40 when held at common (45°-55°F.) and controlled (68°F.) storage for six months.

TABLE 3.—*Variations in tuber weight loss after 6 months' storage of two potato varieties in response to date and concentration of MH-40 spray, and storage temperature. Shafter trial, 1956.*

Variety	Storage Temperature (°F.)	Spray Date Weeks Before Harvest	MH-40 Spray Concentration (ppm)					
			Check	1000	2000	3000	4000	6000
			Per cent	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*
White Rose	Common (45°-55°)	3	8.35	4.98	2.98	2.92	2.40	2.70
		2		6.30	5.43	3.92	3.42	3.17
	Controlled (68°)	3	16.35	4.57	5.17	12.66	2.88	4.89
		2		11.06	6.45	2.92	6.52	5.96
Kennebec	Common (45°-55°)	3	12.62	13.25	14.13	7.52	3.77	5.69
		2		12.87	5.30	5.56	5.69	3.70
	Controlled (68°)	3	18.61	10.13	13.68	11.06	16.72	8.14
		2		13.75	17.01	19.35	8.31	7.76

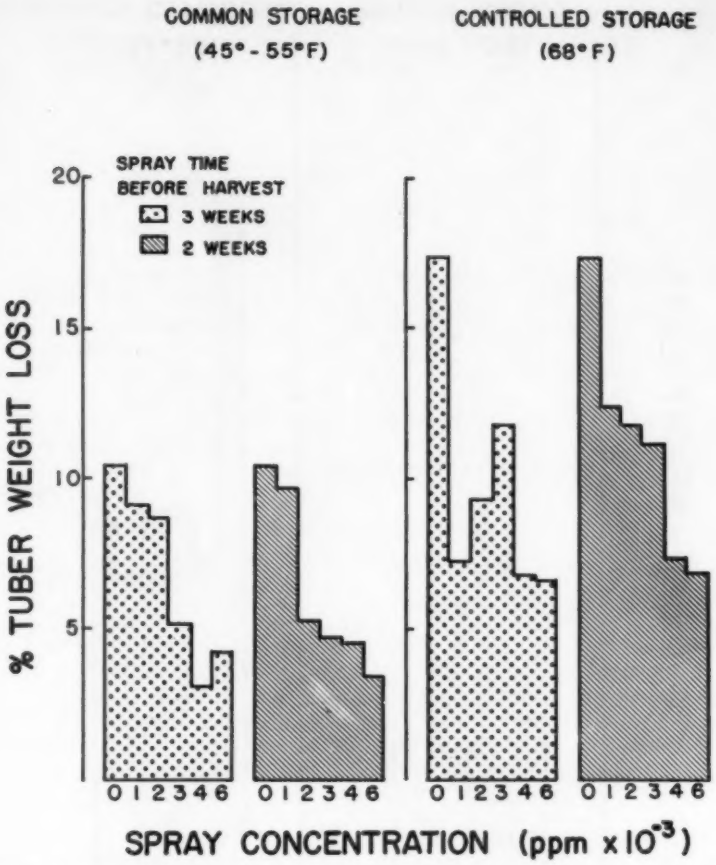

FIGURE 4.—Effect of time of application and concentration of MH-40 on the tuber weight loss of Shafter-treated potatoes after six months' storage.

from treated plants at Tulelake were markedly retarded in sprout development and weight loss. Penetration of MH-40 was apparently good under the relatively cool growing conditions which allowed for more turgid plant foliage.

Low storage temperature (45°-55° F.) was effective in reducing tuber weight-loss of Tulelake-grown potatoes. In this respect applications of MH-40 had no appreciable effect (Figure 5). However, spraying at a concentration of 1000 ppm strongly inhibited sprouting of these same tubers (Figure 2). This suggests that prolonged storage life in bulk or at retail stores would benefit by a reduction in sprout development.

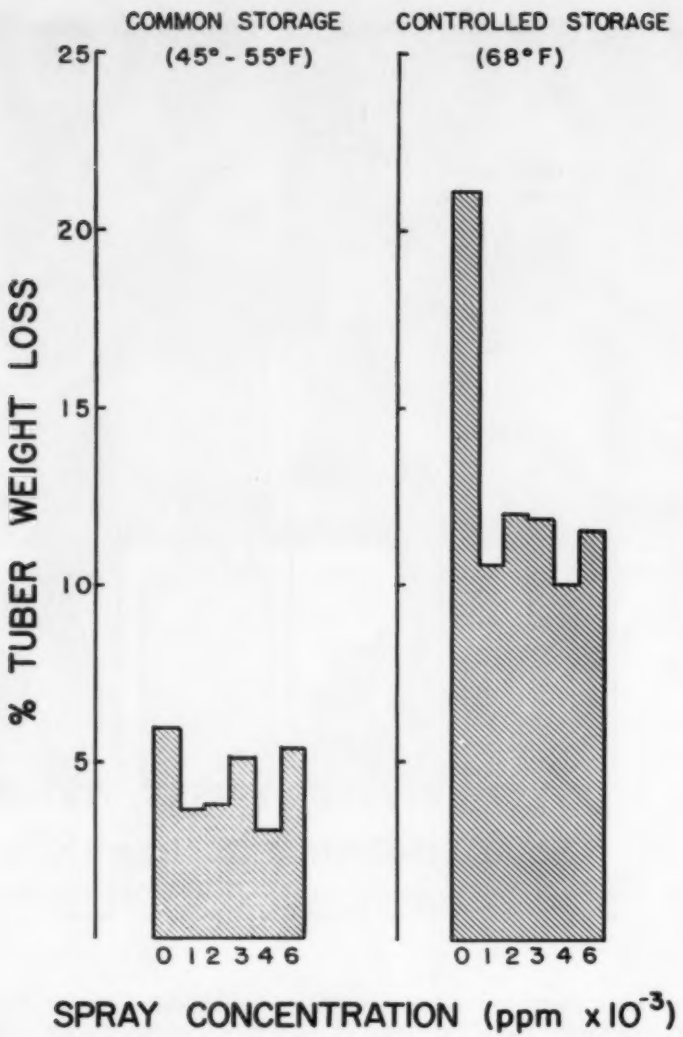

FIGURE 5.—Effect of concentrations of MH-40 on tuber weight loss of Tulelake treated potatoes after six months' storage.

Some sprouting occurred even at the highest spray concentration (6000 ppm) of MH-40. As observed by other investigators (2, 3), complete sprout inhibition was not found. Spray concentrations of 3000 ppm or higher tended to give more uniform control of sprout development and lower tuber weight loss.

SUMMARY

Maleic hydrazide was applied to the foliage of five varieties of potatoes grown at two California locations, Shafter and Tulelake. Plants were sprayed two and three weeks before harvest, and harvested tubers were held for six months at 45°-55° and 68° F.

No significant differences in yield or specific gravity of tubers due to MH-40 spray treatments were found.

Increasing concentrations of MH-40 spray resulted in a reduction in sprout development and loss of tuber weight in stored potatoes. Application three weeks before harvest was more effective in reducing losses in storage than application two weeks before harvest.

A greater loss in tuber weight and more sprouting occurred at 68° F. than at 45°-55° F.

Applications of MH-40 caused no change in chipping or cooking quality of tubers.

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THE RELATIONSHIP BETWEEN PEROXIDASE ACTIVITY IN POTATO LEAVES AND RESISTANCE TO *PHYTOPHTHORA INFESTANS*[1]

VILHELM UMAERUS[2]

INTRODUCTION

Early potato breeding for resistance to *Phytophthora infestans* (Mont.) De By. utilized differences in field resistance of varieties of *Solanum tuberosum* L. to provide a moderate level of protection against late blight.[3] Discovery of a hypersensitive resistance in *S. demissum* L. shifted emphasis to this area of potato breeding. Immune varieties derived from *S. demissum* provided resistance to the common race of late blight, but all succumbed to successively arising specialized races of *P. infestans* soon after their introduction. Recognition of an easily mutable pathogen has once again changed emphasis in breeding back to field resistance to obtain a wider spectrum of resistance.

Field resistance in *S. tuberosum* is generally assessed by prolonged field testing. Quantitative methods such as a chemical test, would provide a uniform and unbiased estimate of resistance that would be particularly useful in a breeding program combining field immunity and field resistance.

The investigation re-examined a chemical test outlined by Norbert Kammermann (7), which is based on a correlation between leaf peroxidase activity and field resistance in *S. tuberosum*, and evaluated his suggestion that screening for field resistance could be based on the comparative peroxidase activity of new seedlings. It was of further interest to examine this correlation in derivatives of *S. demissum* possessing known levels of field resistance.

MATERIALS AND METHODS

Potato varieties of *S. tuberosum* with different levels of field resistance were grown in the greenhouse at Ames during the winter and on peat soil at Clear Lake, Iowa, during the summer, 1957. Leaf samples from derivatives of *S. demissum*, previously screened for field resistance by Dr. J. S. Niederhauser at the Santa Elena Experiment Station, Mexico, were frozen and analyzed in Ames for peroxidase activity. The influence of virus infection on peroxidase activity was studied on plants of two varieties artificially inoculated with a severe strain of potato virus X and on naturally virus-infected plants found in a collection of the variety Essex. Virus-free check plants and virus-infected plants were tested on *Gomphrena globosa* L. to insure freedom from virus X and successful infection with virus X, respectively.

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Journal Paper No. J-3444 of the Iowa Agricultural and Home Economics Experiment Station, Ames, Iowa. Project No. 1184.

[2]Graduate Assistant, Department of Horticulture, Iowa Agricultural and Home Economics Experiment Station. Present address, Swedish Seed Association, Svalov, Sweden.

[3]Field resistance = minor gene, multiple gene, multigenic, and polygenic resistance; field immunity = hypersensitive, major gene, and dominant gene resistance. Varieties of *S. tuberosum* refer to those selections with only *S. tuberosum* parentage; *S. tuberosum* × *S. demissum* hybrids, and *S. demissum* only are referred to as such.

Estimation of field resistance level was based on leaf reaction to infection by *P. infestans*. Kammermann (6) described three such methods: extent of sporulation, lesion size when sporulation first occurs, and the ratio n/m where n = necrotic leaf area and m = leaf area visibly penetrated by mycelium. Estimation of sporulation extent was not reliable, but the other two methods were employed with success. A consistent interpretation of n/m used the following definitions: n = necrotic leaf area where fungus is mostly nonsporulating; m = leaf area where the fungus is sporulating and the host tissue is still living. Regular spread of the fungus in a circular pattern was obtained by placing a small drop of zoospore suspension on a dry surface of each leaflet. Inoculated detached leaves were placed on moist sphagnum moss in wooden flats, covered with glass, and held at 15°-18° C. After 48 hours, the flats were uncovered but were kept in a water-saturated atmosphere. When sporulation started, lesion size was measured with a vernier caliper. Sporangiophores were removed from each lesion to permit an accurate measurement of the sporulating zone during the succeeding 24 hours. Leaves were then exposed to a drying atmosphere for an hour or two during which the color of the necrotic area changed, permitting accurate measurements of "n' and "m."

Cultures of *P. infestans* were obtained from Dr. J. Horton (Race *0*) and Dr. J. R. Wallin (a mixture of races *1* and *2,4*). Stock cultures were maintained on soybean-dextrose agar, and working cultures were maintained on Cobbler leaves.

Samples to be used for the chemical test were usually 10 grams of mature leaflets. Samples were commonly wrapped in aluminum foil and stored at —29°C. Stability of peroxidase activity in frozen leaves was examined many times, but no change in activity was evident for at least 14 days after sampling. Similarly, no differences were found in activity between fresh and frozen samples. This storage technique permitted collection of many samples within a very short period and reduced variation due to environmental effects.

For enzyme analysis, fresh or frozen leaflets were weighed to the nearest 0.1 gm., diluted 1:11 (w/w) with ice-cold distilled water and ground in an Omni-mixer for five minutes in an ice bath. About 10 ml. of this suspension was transferred to a Potter-Elvehjem homogenizer in an ice bath. The resulting homogenate was diluted with cold 0.5 per cent gelatin to correct concentration for assay.

Enzyme activity was assayed at 30°C. by the colorimetric method of Smith *et al.* (15) using Eastman Kodak 2,3',6-tri-chloroindophenol kept in a reduced form. Colorimetric procedures were as follows. To a colorimeter tube were added 0.5 ml. of 0.2 M phosphate-citrate buffer (pH 6.0), 1.2 ml. water, 0.2 ml. of 0.3 per cent hydrogen peroxide, 1.0 ml. of 1.3×10^{-3} M leuco or reduced dye, and 0.1 ml. of the enzyme preparation. Tube contents were mixed with a rotary motion and placed quickly in a Lumetron colorimeter with a 640 mμ filter. Readings were taken at five-second intervals during the 15- to 60-second interval following enzyme addition. Percentage transmission was plotted against time on semilogarithmic paper. Plotted rate, expressed as change in optical density (ΔD/min.), was converted to an absolute basis as follows: $D \times \frac{1}{E \times L} \times G =$ Absolute rate

(micromoles/min. × gm.), where E is dye extinction value, L is light path, and G is grams of fresh-weight tissue in reaction mixture. Further E ×L, calculated as a single constant with one colorimeter tuber, was 43. Under conditions adopted as standard, reaction rates were directly proportional to enzyme concentration over at least an eightfold range.

Results and Discussion

Evidence was found, as reported by Kammermann (7), that a positive relationship does exist between field resistance to late blight in *S. tuberosum* and peroxidase activity in the foliage. Tables 1 and 2 show that varieties of *S. tuberosum* with a low level of field resistance had a correspondingly low peroxidase activity. Similarly, varieties with a high level of field resistance had a peroxidase activity 50 per cent or more greater than that of the low level.

Comparison of these two tables also reveals that greenhouse plants always had a lower peroxidase activity than did field plants. Of the factors contributing to this difference, light conditions (especially day-length) are most influential according to both Grechushnikov (4) and Kammermann (7). The former author suggests that light has direct influence on the level of field resistance. He noted that peroxidase activity decreased with shorter day-length in all varieties tested, with some decreases as high as 50 per cent. Kammermann (7) concluded that plants grown under suboptimal light conditions would show a better correlation between peroxidase activity and resistance than would plants grown under optimal conditions, if a true relationship existed.

This light effect is shown by data in tables 2 and 3 on peroxidase activity of the variety Alpha under field conditions in Iowa and in Mexico. Activity in plants from Iowa was 381 μM/min. × gm., but in plants from

Table 1.—*Peroxidase activity of leaf extracts from potato varieties grown in greenhouse and comparative resistance of those varieties to late blight.*

Variety	Peroxidase Activity		Resistance
	μM/min. x gm.[1]	Relative[2]	n/m[3]
Alpha	352	100	0.8
Jubel	339	96	
Voran	292	83	0.8
Centifolia	233	66	1.0
Earlaine	191	54	0.4
Ontario	179	51	
Pontiac	117	33	0.4
Cobbler	107	30	0.3
161725[4]	102	29	
Katahdin	99	28	0.1
Ac 25953	73	21	

[1]Average of six plants.
[2]Percentage of activity given by Alpha.
[3]n = necrotic leaf area where fungus is nonsporulating and m = leaf area where fungus is sporulating and the host tissue living. A high ratio indicates resistance.
[4]*Solanum demissum.*

TABLE 2.—*Peroxidase activity of leaf extracts of potato varieties grown in field at Clear Lake, Iowa, and relative resistance of such varieties to late blight.*

Variety	Peroxidase activity		Resistance
	μM/min. x gm.[1]	Relative[2]	n/m[3]
Alpha	381	*100*	0.8
Centifolia	374	98	1.0
Voran	351	92	0.8
Ackersegen	329	86	1.0
B3821-Ia2	315	83	0.9
Hindenburg	303	80	
Earlaine	229	60	0.4
Ac 25953	217	57	
Pontiac	206	54	0.5
Bintje	189	50	0.4
Cobbler	183	48	0.3
3XX-1	135	35	

[1]Average of four plants.
[2]Percentage of activity given by Alpha.
[3]n = necrotic leaf area where fungus is non-sporulating and m = leaf area where fungus is sporulating and the host tissue living. A high ratio indicates resistance.

TABLE 3.—*Peroxidase activity of leaf extracts of S. tuberosum x S. demissum derivatives grown in field at Toluca, Mexico, and comparative field resistance of these derivatives.*

Variety	Peroxidase Activity, μM/min. x gm.					Field Resistance[1]
	Sample No.				Average	
	1	2	3	4		
Hol 37	114	116	118	108	114	1
54 Q-2	114	82	81	70	87	1
Dona Rosa	125	245	206	180	189	1
US 144-12	176	128	135	173	153	4
US 145-1	124	125	123	199	143	4
US 202-13	117	165	146	130	140	4
Alpha (*S. tuberosum*)	167	154	203	167	172	5

[1]Four-year average. Group 1—very few lesions. Group 4—severely blighted. Group 5—plants dead.

Mexico it was only 172 μM/min. × gm. Furthermore, activity levels below 200 μM/min. × gm. are typical of susceptible varieties, such as Cobbler and Bintje, grown in Iowa. Variety Alpha grown in Minnesota shows a high level of field resistance; variety Alpha grown in Mexico is susceptible unless protected with a fungicide. These results suggest a definite relation of field resistance with peroxidase activity in *S. tuberosum*. Similarly, the variety Sebago is considered highly field resistant when grown under long day-lengths in Maine, but it is probably one of the most susceptible varieties when grown under short day-lengths during the winter in Florida.

TABLE 4.—*Peroxidase activity of S. tuberosum leaves of different age.*[1]

Variety and Leaf Positions	Plant Number				Average
	1	2	3	4	
B 3319-10					
Top	78	132	173	140	131
Middle	129	194	182	204	177
Bottom	156	134	166	223	170
ND 2910-1					
Top	109	106	107	100	106
Middle	144	181	130	122	144
Bottom	205	208	142	199	189

[1]Data are given as μM/min. x gm.

Leaf age has a definite effect on peroxidase activity (Table 4). Juvenile leaves have a lower activity than have mature leaves. Müller and Munro (10), investigating different leaf response to infection by *P. infestans*, found that all young leaves were more susceptible than older leaves. They showed an increase in susceptibility with a decrease in leaf age as determined by the number of successful infections and intensity of sporulation. Common experience is, however, that disease signs occasionally appear on basal leaves of field plants despite the fact that these leaves are senescent and not so susceptible. This condition usually arises when the original infection starts from an infected tuber. If spores are blown into the field from an infected area outside the field, a large percentage of the initial infection takes place on the more susceptible upper young leaves. Microclimatic conditions often are more favorable (for disease development) under the plant canopy close to the soil surface than are those at the top of the plant. It was concluded that as leaves mature there is an increase in peroxidase activity, as well as an increase in resistance.

Influence of virus infection on leaf enzyme activity was explored following a suggestion by Rouzinoff (14) that certain virus infections increase peroxidase activity. Peroxidase activity of virus-infected plants was found to be 1.6 to 1.8 times greater than that of corresponding virus-free plants grown from the same mother tuber (Table 5). Müller and Munro (10) report virus-infected plants are less affected by blight than are healthy plants, but they credit decreased susceptibility to a passive factor such as an alteration of mechanical structures in epidermal cells by the virus They also observed a decreased fungal growth rate in virus-infected tissues and suggested alteration by another, non-mechanical factor. This factor may well be a change in peroxidase activity.

Results of this investigation as well as those of other workers appear to support the theory that increased peroxidase activity in *S. tuberosum* provides field resistance to *P. infestans*.

This relationship is non-existent in *S. tuberosum* × *S. demissum* derivatives grown in Mexico (Table 3), although these hybrids show a high degree of field resistance. According to Niederhauser (12,13), *S. demissum* has a high level of field resistance that enables the species to survive extraordinary late blight conditions. This resistance must be much greater than its counterpart in *S. tuberosum*. Some hybrids of *S. tuberosum*

TABLE 5.—*Comparison of peroxidase activity of potato plants free of virus X and of plants grown from the same mother tubers but infected by virus X.*

Variety	μM/min. x gm.		Percentage Increase
	Virus Free[1]	Virus Infected[2]	
I 8140-6	174	311	179
I 912-6	127	216	170
"	147	228	162
I 8140-1	203		
"	193		
"	186		
	Average 194	338	174
I 912-6	146	372	
"	198	262	
"	180	231	
"	130		
"	164		
	Average 164	288	176
Essex	170	358	
"	172	205	
"	147	298	
		276	
		180	
	Average 163	263	161

[1]No symptoms on *Gomphrena globosa.*
[2]Distinct symptoms on *G. globosa.*

× *S. demissum* tested in Mexico survive epiphytotics with only a few lesions, indicating genetic transmission of field resistance derived from *S. demissum.*

Presence of even a few lesions indicates that resistance is not of the immune type, and restricted numbers of infection implies a mechanism different from the usual type of field resistance derived originally from *S. tuberosum.* Mechanisms for resistance in *S. tuberosum* plants essentially impede pathogen progress through leaf tissue and for this paper is referred to as "resistance to invasion"[4]. In Mexico, plants with field resistance derived originally from *S. demissum* retain this resistance under conditions ideal for fungal development and sporulation. If ingression occurs in such plants, infections would be so multiple as to preclude any escapes, even if the fungus grows very slowly in the host. For this reason, this paper indicates this resistance mechanism to infection in *S. demissum* hybrids as "resistance to ingression"[4]. An excellent screening procedure

[4]In the following discussion, these two principles of resistance are described as resistance to ingression (in *S. demissum*) and resistance to invasion (in *S. tuberosum*) using the terminology of Leach (8, pp. 101-102), where "'ingression is defined as the act of gaining entrance into the tissues of the suscept and "invasion" as spread of the pathogen through the tissues of the suscept; resistance to penetration and resistance to spread as used by Gäumann (3) would serve the same purpose, but the sense of "penetration" is too distinct to be used, and "spread" gives association of spread of the disease in the field.

is available in Mexico, but it is not known what type of field resistance this screening produces. If a true relationship exists between peroxidase activity and field resistance derived solely from *S. tuberosum*, and if the short day-length at this latitude decreases peroxidase activity, screening for tuberosum field resistance can not be accomplished in Mexico. On the other hand the peroxidase activity test can be used only for detection of resistance to invasion and thus has its limitations as a general test for field resistance. A combination of as many immune genes as possible and a high level of field resistance is desired by both American and European breeders. An equally desirable goal may be the combination of resistance to ingression with resistance to invasion. Further investigation is essential to define the limits and capabilities of each resistance type and to speed their incorporation into desirable varieties.

A recent survey by Farkas and Kiraly (2) reinforces the widely accepted theory of enzyme influence on host reaction and defense mechanism. The role of polyphenolases in infection and disease development has been more intensively studied than has that of peroxidase. Christiansen-Weniger (1) demonstrated that inhibition of several specific oxidase activities, especially polyphenolases, tended to increase the susceptiblity of potato tuber tissue of *P. infestans*. Hungarian workers (16) report that a streptomycin-induced resistance to *P. infestans*, earlier demonstrated by Müller *et al.* (11), may be the result of a tsrong stimulation of polyphenolase activity. Phenolic compounds and their derivatives also may be associated with plant disease resistance (5). Dark colorations in late blight lesions are described as tannins (9) or melanine (4,17), and are both end results of oxidation processes. Peroxidase, in the presence of peroxide, oxidizes a wide variety of monophenols and diphenols and thus may play an important role in the accumulation of pathogen-induced fungistatic or fungicidal oxidation products.

Activity of thirteen phenoloxidases were assayed, but only small intensities were obtained. Chlorogenic acid was the best mediator, but no correlation with field resistance existed. Biochemical aspects of the resistance mechanism reveal that enzymatic activities play a major role, although details of these functions are imperfectly known.

The original question of a correlation of field resistance in hybrids of *S. demissum* × *S. tuberosum* with peroxidase activity is still not answered. Hybrids investigated were probably screened for resistance to ingression rather than to invasion. The possibility still exists that hybrids grown under optimal light conditions are resistant to both ingression (*S. demissum* type of field resistance) and to invasion (*S. tuberosum* type of *field resistance*) and thus may have a high peroxidase activity as found in *S. tuberosum*.

Summary

Peroxidase activity was found to be positively correlated with field resistance in *Solanum tuberosum* L. but not in *S. demissum* L. and its derivatives. Tehes results confirm earlier suggestions taht peroxidase activity could be used as a test of field resistance associated with *S. tuberosum*. Light, leaf age, and virus infection influenced the level of field resistance in *S. tuberosum*, and conditions which decreased peroxidase activity. The

field resistance found in *S. demissum* and its derivatives was not correlated with peroxidase activity. It was suggested that field resistance in S. *demissum* could be a resistance to ingression, and that field resistance in *S. tuberosum* could be considered as resistance to invasion.

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SOME EFFECTS OF SOURCES OF NITROGEN AND BIURET ON POTATOES[1]

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INTRODUCTION

Recent research has indicated that biuret is formed during the pelleting of urea when the temperature exceeds 271 degrees F. (6). In a review on the mineral nutrition of tree crops, Reuther *et. al.* (5) reported that biuret is selective in its toxic action on plants and that urea containing no more than 0.25 per cent biuret is commercially safe as a foliage spray on citrus. It has also been concluded by Webster *et al* (8) that biuret directly or indirectly inhibits protein synthesis of *Xanthium pennsylvanicum.*

The objective of this study was to determine some of the effects of biuret on potato plants. To this end, various nitrogen sources were used with and without the inclusion of biuret.

MATERIALS AND METHODS

In this study, Katahdin potatoes were grown in nutrient culture within a plastic, semi-control chamber. This chamber was used to maintain the air temperature at approximately 70 degrees F. and to give supplemental light to simulate a day length of 14 hours.

Glazed crocks, which were washed with a one per cent $CuSO_4$ solution and rinsed thoroughly with distilled water, were used to contain the nutrient solution. After adding 3500 ml. of nutrient solution, which remained unchanged throughout the experiment, fiber screening holding approximately 3-inches of vermiculite was placed within the top portion of each crock. One Katahdin potato seed piece previously treated with a solution of 100 p.p.m. Agrimycin was planted in the vermiculite in each crock on December 17, 1957. Each crock was then covered with tempered hardboard which was coated with aluminum paint to discourage algal growth. The hardboard had centered holes for plant emergence and growth. Nonabsorbent cotton was used to hold single potato stems in position in the centered holes. The nutrient solutions were aerated with Thiberg aerators,[3] and water was added throughout the experiment in a quantity to maintain the initial level of each crock.

The experimental design was a randomized complete block in quadruplicate. Ten treatments were used consisting of five N sources each applied at a rate of 160 pounds per acre with and without the addition of biuret at a rate of 0.03 per cent. The sources of N from reagent grade chemicals were: [1] all N from ammonium nitrate (NH_4NO_3); [2] all N from ammonium sulfate $(NH_4)_2SO_4$; [3] all N from urea $CO(NH_2)_2$; [4] ½N from NH_4NO_3 + ½N from $CO(NH_2)_2$; and [5] ½N from $(NH_4)_2SO_4$ + ½N from $CO(NH_2)_2$.

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Phosphorus, K and Mg were added at 140, 266, and 40 pounds per acre, respectively. These nutrients were obtained from the following reagent grade chemicals: KH_2PO_4, K_2SO_4, MgO, $CaSO_4$, and $CaCl_2$. Calcium sulfate and $CaCl_2$ were supplied in a 1:1 ratio on a molecular weight basis. Minor elements were added in approximate accordance with Broyer *et al* (1) as follows, in micromoles per liter: Fe,80; B,40; Mn,10; Zn,0.7; CuO,O.3; and Mo,0.10.

Procedures as given by Snedecor (6) were followed in the statistical analyses of the data. Missing plots were calculated for two treatments, each in separate blocks. These treatments were: ½N from NH_4NO_3 + ½N from $CO(NH_2)_2$ + biuret and ½N from $(NH_4)_2SO_4$ + ½N from $CO(NH_2)_2$ + biuret.

Data accumulated during the experiment includes the following: [1] height measurements at 3 to 7 day intervals; [2] growth characteristics and visual plant symptoms; [3] dry weights of roots, tubers, tops; [4] quick tests for nitrate and ammonia in nutrient solutions following procedures as given by Jackson (2); [5] chemical analyses for percentages of Ca, K, P, and N in combined samples of tops, roots, and tubers after procedures given in A.O.A.C. (3), and [6] final pH determinations on the nutrient solutions. The potatoes were harvested approximately 65 days after planting.

Results and Discussion

Effects on Dry Matter Production

The effects of sources of N with and without the addition of 0.03 per cent biuret on the dry matter production of tops, roots, and tubers of potato plants are shown in table 1. It is noted that the highest average dry matter production occurred when NH_4NO_3 was the source of N. Although the interaction of treatments with tops, roots, and tubers was not statistically significant, an interesting result is the increased dry weight of tubers when $(NH_4)_2SO_4$ and $CO(NH_2)_2$ were combined to furnish the N. In this respect, there was an approximate two-fold increase in tuber yield as compared with tuber yield when only $(NH_4)_2SO_4$ was used as the N carrier.

It is especially significant that the addition of biuret to the sources of N gave a concomitant reduction in total dry matter production. The greatest decrease occurred when the $(NH_4)_2SO_4$ — $CO(NH_2)_2$ combination was used to furnish the N.

Although the analysis of variance did not indicate that N treatments had a significant effect on the pH of the nutrient solutions, a significant correlation of —0.576 was found between the final pH of nutrient solutions and the total dry weight of potato plants. The final pH values, as an average of four replications, ranged from 4.14 to 6.85 with the $(NH_4)_2SO_4$ treatment causing the most acidity and the $CO(NH_2)_2$ treatment causing the least acidity. This would seem to indicate that some adjustment of pH should be made in further studies of this type.

Effects of Composition

Table 2 depicts the percentages of N, P, Ca, and K found from the chemical analyses of combined samples of tops, roots, and tubers of

TABLE 1.—*Effect of N source and biuret on the dry weight of potato plants, average of 4 replications.*

Nitrogen Source†	Tops	Roots	Tubers	Mean
	Gms.	Gms.	Gms.	Gms.
NH_4NO_3	11.21	3.71	2.29	5.74
$(NH_4)_2SO_4$	6.53	2.36	1.50	3.46*
$CO(NH_2)_2$	9.04	3.27	1.55	4.62
½ NH_4NO_3 + ½ $CO(NH_2)_2$	8.49	2.77	1.88	4.38
½ $(NH_4)_2SO_4$ + ½ $CO(NH_2)_2$	8.79	2.95	2.78	4.84
NH_4NO_3 + Biuret	8.90	3.10	1.92	4.64
$(NH_4)_2SO_4$ + Biuret	5.00	1.72	1.06	2.59**
$CO(NH_2)_2$ + Biuret	7.17	2.38	1.52	3.69*
½ NH_4NO_3 + ½ $CO(NH_2)_2$ + Biuret	7.15	3.03	1.69	3.96*
½ $(NH_4)_2SO_4$ + ½ $CO(NH_2)_2$ + Biuret	4.25	2.40	1.20	2.62**
Mean	7.65	2.77	1.74	

*Significant at 5 per cent level compared with NH_4NO_3.
**Significant at 1 per cent level compared with NH_4NO_3.
†Fractions indicate amounts of N added from respective carriers.

TABLE 2.—*Effects of N source and additions of biuret on the percentage composition of N, P, Ca, and K in potato plants (Data represent the mean of 4 replications from combined samples of roots, tubers and tops).*

Source of Nitrogen and Biuret Treatment†	Percentage Composition			
	N	P	Ca	K
NH_4NO_3	3.087	0.679	0.325	3.640
$(NH_4)_2SO_4$	4.637	0.652	0.138	2.732
$CO(NH_2)_2$	3.862	0.671	0.333	4.337
½ NH_4NO_3 + ½ $CO(NH_2)_2$	3.390	0.405	0.373	3.875
½ $(NH_4)_2SO_4$ + ½ $CO(NH_2)_2$	4.332	0.697	0.153	3.775
NH_4NO_3 + Biuret	3.250	0.707	0.385	5.025
$(NH_4)_2SO_4$ + Biuret	4.565	0.678	0.175	3.182
$CO(NH_2)_2$ + Biuret	3.957	0.680	0.353	4.637
½ NH_4NO_3 + ½ $CO(NH_2)_2$ + Biuret	4.245	0.405	0.385	3.892
½ $(NH_4)_2SO_4$ + ½ $CO(NH_2)_2$ + Biuret	4.853	0.612	0.240	3.492
L.S.D. 5 per cent level	1.070	N.S.	0.146	1.129
L.S.D. 1 per cent level	N.S.	N.S.	0.197	1.527

†Fractions indicate amounts of N added from respective carriers.

the potato plants. It is worthy of note that sources of N significantly affected the percentage composition of N, Ca, and K. These data are indicative of the following conclusions: [1] $(NH_4)_2SO_4$ alone or in combination with $CO(NH_2)_2$ or biuret increased the N content and reduced the Ca content of potato tissues, and [2] $CO(NH_2)_2$ alone or in combination with NH_4NO_3 or biuret increased the K content with very little effect on the Ca or N content.

The effects of biuret on the percentages of N, P, Ca, and K in the potato tissues are summarized in table 3. The addition of biuret to all N sources generally tended to increase the percentages of P, Ca, and K. It is noted, however, that this increase tended to be greater with NH_4NO_3 than with $(NH_4)_2SO_4$. In addition, NH_4NO_3 with biuret increased the

percentages of N; whereas $(NH_4)_2SO_4$ with biuret decreased the percentage of N. Urea with biuret tended to increase N, Ca, and K, but a differential response was obtained when $CO(NH_2)_2$ and biuret were included with NH_4NO_3 or $(NH_4)_2SO_4$. The NH_4NO_3 + $CO(NH_2)_2$ + biuret combination greatly increased the percentage of N and tended to decrease the Ca and K contents; whereas, the combination of $(NH_4)_2SO_4$, $CO(NH_2)_2$, and biuret greatly increased the Ca content but decreased the percentages of P and K.

The results seem to indicate that the NH_4^+ ion interacts most readily with biuret to affect the nutrient content of the potato plant. As noted in table 3, additions of biuret to $CO(NH_2)_2$ or NH_4NO_3 did not decrease the percentages of N, P, Ca, or K. This was not true with $(NH_4)_2SO_4$. In this respect, further studies are needed to relate interacting effects of N carriers with biuret to metabolic processes within the potato plant.

TABLE 3.—*Increase (+) or decrease (—) in percentage composition of N, P, Ca, and K because of additions of biuret to various N sources (data represent the mean of 4 replicates from combined samples of roots, tubers, and tops).*

Nitrogen Source†	Increase (+) or Decrease (—) in Percentage Composition from Additions of Biuret			
	N	P	Ca	K
NH_4NO_3	+0.163	+0.028	+0.060	+1.386
$(NH_4)_2SO_4$	—0.072	+0.026	+0.037	+0.450
$CO(NH_2)_2$	+0.095	+0.009	+0.020	+0.300
½ NH_4NO_3, ½ $CO(NH_2)_2$	+0.855	0.0	+0.012	+0.017
½ $(NH_4)_2SO_4$, ½ $CO(NH_2)_2$	+0.521	—0.075	+0.087	—0.283

†Fractions indicate amounts of N added from respective carriers.

Effects on Nitrification

Quick tests for NO_3^- and NH_4^+ in the nutrient culture solutions indicated that biuret inhibits nitrification (data not included). Essentially, a test for NO_3^- was not obtained when biuret was added to N sources which contained $(NH_4)_2SO_4$, $CO(NH_2)_2$, or the $(NH_4)_2SO_4$ + $CO(NH_2)_2$ combination, although high amounts of NH_4^+ were always indicated. A test for NO_3^- was obtained when biuret was not added to $(NH_4)_2SO_4$ + $CO(NH_2)_2$ or the $(NH_4)_2SO_2$ + $CO(NH_2)_2$ combinations. This supports the findings of Ogata and Funabiki (4) who reported that the presence of biuret in the soil did not affect the rate of ammonification of urea, but that it did inhibit nitrification.

Effects on Growth

The addition of biuret to the N sources significantly decreased the height of plants which received the following treatments (data not included): NH_4NO_3 + $CO(NH_2)_2$, $CO(NH_2)_2$, and $(NH_4)_2SO_4$ + $CO(NH_2)_2$.

Various plant symptoms were encountered with treatments which had the biuret additions. These most typically consisted of leaf curling and reddish brown discoloration of leaflet margins in terminal leaves of the

potato plant. In addition, the stems of these plants often had intensive browning. The leaf curling was accentuated by treatments which contained $(NH_4)_2SO_4$.

Summary and Conclusions

1. Sources of N influenced the dry matter production of tops, roots, and tubers of potato plants in greenhouse nutrient culture. The greatest total dry matter yield was obtained with NH_4NO_3, and a combination of ½N from $(NH_4)_2SO_4$ and ½N from $CO(NH_2)_2$ gave the highest tuber yield.
2. Ammonium sulfate alone or in combination with $CO(NH_2)_2$ increased the percentage of N and reduced the percentage of Ca; whereas, $CO(NH_2)_2$ alone or in combination with NH_4NO_3 tended to increase the K content with very little effect on the Ca and N content.
3. The addition of biuret at a rate of 0.03 per cent to various N sources decreased dry matter production in all instances.
4. Biuret caused many variations in the percentages of N, P, Ca, and K in potato plants grown with various N sources. .The NH_4^+ ion appeared to interact more than NO_3^- with biuret in affecting the nutrient contents.
5. Biuret inhibited nitrification in nutrient solutions.
6. Typical plant symptoms are described which were obtained on plants grown with biuret in the nutrient solutions.

Acknowledgment

The authors wish to express their thanks to Miss Rose House for her help in this study.

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NEWS AND REVIEWS

A SIMPLIFIED METHOD OF ISOLATING SINGLE CELLS OF STEPTOMYCES[1]

LAWRENCE A. SCHAAL AND L. W. DIRRELL[2]

The cells of *Streptomyces scabies* (Thaxt. Waks. and Henrici) are extremely small and difficult to work with. Since the genus tends to mutate or produce variants readily in culture media, it is essential to work with single cell cultures. Streptomyces cells are very resistant to wetting and tend to clump in water or culture media preventing even distribution of individual cells (Figure 1).

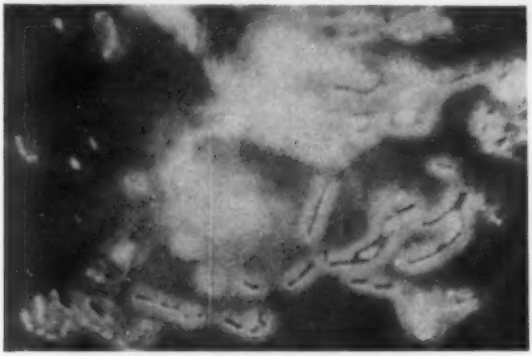

FIGURE 1.—Cells of a Streptomyces culture No. 210-A in water containing no sodium lauryl sulfate (magnification 2200 X. Phase contrast). The cells are not separated and chains are common.

In the past the use of the micromanipulator has been the most dependable method employed in obtaining single cells. As this instrument is not available to many workers, the cell isolation method described here is a good substitute, it is an adaption of a technique described by Anderson and Henry[3]. A culture of Streptomyces old enough to produce a maximum amount of aerial growth is selected, a small quantity of cells is taken from the surface of the colony with the tip of a transfer needle and placed in 10 ml of sterile water containing a quantity of a dissolved detergent, sodium lauryl sulfate, equal to that of a small crystal of sugar. The cells are then shaken vigorously for 20 to 30 seconds in the water containing the detergent (Figure 2). After 3 serial dilutions of 0.5 ml of the suspension to 10 ml of sterile water containing the detergent, .5 ml is pipetted to the surface of solidified modified potato dextrose agar medium in Petri plates. The cell suspension is spread evenly over the surface of the agar medium by tipping and rotating the plates. After 48 hours the plates are examined under the microscope and the small Streptomyces colonies are readily observed and can be picked from the medium with a needle (Figure 3).

FIGURE 2.—Dispersal of the Streptomyces cells from culture 410-A in water containing the detergent. Most of the cells are separated.

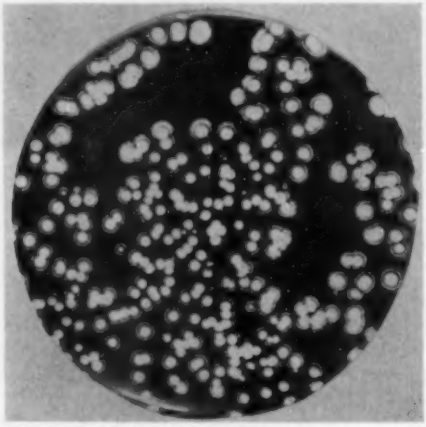

FIGURE 3.—Colonies of 410-A after 6 days growth from dispersed cells seeded on modified potato dextrose agar medium. Distribution was such that the germinating single cells and resultant small colonies can be readily picked up 24 hours after plating. Mixed cultures of divergent types of Streptomyces were also treated as described and the resultant colonies showed that this is an effective method in obtaining single cell isolates.

[1]Accepted for publication December 8, 1958.
Cooperative Investigations of Crops Research Division. United States Department of Agriculture and the Colorado Agricultural Experiment Station. Published with the approval of the Director of the Colorado Agricultural Experiment Station, Fort Collins, Colo., as Scientific Journal Series No. SS.562.
[2]Senior Pathologist, Crops Research Division, Agricultural Research Service and Professor of Plant Pathology, Emeritus Dean, College of Science and Arts, Colorado State University, respectively.
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BOOK REVIEW

HANNA'S HANDBOOK OF AGRICULTURAL CHEMICALS. Second Edition by Lester W. Hanna. Forest Grove, Oregon.

Published by Lester Hanna, Rt. 1, Box 210, Forest Grove, Oregon, Price $5.95.

This 490 page Handbook contains a 250 page glossary of the common and chemical names of most agricultural chemicals including fertilizers, fungicides, insecticides, herbicides, etc.

There is also a list of Food & Drug Administration Residue Tolerances on all crops, a copy of the Miller Bill, chemical compatability and weather charts and many other informative chapters for everyone interested in any phase of agriculture.

Research and extension workers as well as county agents and technical and salesmen representing agricultural chemical manufacturers will find this a very helpful book.

"RESULTS OF 1958 FUNGICIDE TESTS"

The American Phytopathological Society for several years has sponsored the publication of results from tests on newer fungicides. The "Results of 1958 Fungicide Tests" has again been printed privately and is issued as a single copy. Copies can be secured at $1.00 per copy only from Dr. A. B. Groves, Department of Plant Pathology and Physiology, Winchester Fruit Research Laboratory, Rural Route 3, Winchester, Virginia. All orders should be accompanied by remittances made out to The American Phytopathological Society. An added charge will be made for postage and handling where orders must be billed.

POTATO PROCESSING

POTATO PROCESSING. By W. F. Talburt, Chief, Western Regional Research Laboratory, U. S. Department of Agriculture, and Ora Smith, Professor of Vegetable Crops, Cornell University and Director of Research, Potato Chip Institute International.

Published by the AVI Publishing Co., Inc., 26 Taylor Place, Westport, Connecticut. Price $9.50 in U.S.A.; foreign countries $10.50.

This is the first book to cover all phases of potato processing including descriptions of processing procedures for all types of frozen, dehydrated and canned products, as well as, for potato chips. Suggestions on growing, selecting and storing potatoes for processing are presented. Preferred varieties, disease problems and handling equipment are also discussed in deteail.

This book, of almost 500 pages, is well illustrated with over 100 pictures on all phases of potato processing.

It is an excellent reference book for all processors, as well as, for those engaged in growing or supplying potatoes for processing. This book is also arranged so that it can be used as a text for college courses covering the handling, storage and utilization of potatoes.

Copies may be ordered through the Potato Association of America.

CALL FOR PAPERS

The 43rd Annual Meeting of the Potato Association of America will be held at the University of New Brunswick, Fredericton, Canada, August 13 through 15, 1959. A field trip to the potato growing areas of northern New Brunswick will be conducted on August 12 and another on August 16 to the Potato Breeding Station at the National Park in Alma.

Please send titles of papers to be presented at this annual meeting to Robert V. Akeley, Crops Research Division, Plant Industry Station, Beltsville, Maryland, by May 15. Along with the title please include: (a) approximate time required to present your papers, (b) if an illustrated talk, the size of the slides to be used, and (c) the names and official addresses of the authors as you wish them to appear on the program. As has been our custom, we will again distribute mimeographed abstracts of these papers to members attending the annual meeting. These abstracts will be published in the American Potato Journal. Therefore, abstracts should accompany the titles of the papers. Abstracts should not exceed 250 words. Presentation of papers should not exceed 15 minutes, and the use of 2 x 2 slides is preferred.

We would like to receive good papers concerned with problems in potato breeding, diseases, production, quality, nutrition, storage, transportation, and marketing. We expect to have at least one session devoted to invitational papers presented by European research workers.

Your cooperation in sending the titles and abstracts as early as possible will aid in the mimeographing of these abstracts and the prompt preparation and printing of programs. Titles and abstracts received after our deadline of May 15 may not be accepted. Please bring this notice to the attention of your students and colleagues.

R. V. AKELEY, *Secretary*

USDA REPORTS ESTIMATED NORMAL CROP USE OF LAND NOW IN CONSERVATION RESERVE

Several million acres which have normally been planted to leading crops will be included in the Conservation Reserve of the Soil Bank in 1959, the U.S. Department of Agriculture reported on the basis of a recent survey of program participation.

The Conservation Reserve is the continuing part of the Soil Bank under which farmers contract to withhold general farmland from production for periods of 3, 5 or 10 years, while they are carrying out soil,water, and wildlife conservation practices.

A total of 23.2 million acres is expected to be under contract in the program for 1959—including an estimated 13.2 million acres from the current sign up which is still in progress, and approximately 10 million acres from contracts signed in previous years.

Estimates of former crop use on this Reserve land include: 3.7 million acres normally devoted to corn; 3.6 million to oats; 3.5 million to grain sorghums; 2.4 million to wheat; and about 10 million acres to other crops, hay and pasture, and special uses including 32,000 acres of potatoes. These acreage estimates do not represent only changes in land use between 1958 and 1959. A substantial part of the acreage involved was put under Conservation Reserve contracts in 1958 or earlier years.

Data for the estimates were taken in sample areas from contracts, applications for contracts, and performance reports which are available in local county Agricultural Stabilization and Conservation (ASC) offices. Farmers have supplied crop records for the two years preceding the first year each farm participated or has been signed up to participate in the program.

FEDERAL-STATE RESEARCHERS DEVELOP VERSATILE ROW-CROP SPRAYER-DUSTER

A versatile row-crop sprayer-duster, developed cooperatively by U.S. Department of Agriculture and State researchers for control of aphids on potato plants, holds promise for use on several other low-growing row crops.

Used successfully in aphid-control tests during the last three years in potato-growing areas of Oregon and Washington, the sprayer-duster will be tried out as a means of applying insecticides to lettuce and broccoli.

Tests have demonstrated the flexibility of the sprayer-duster. It can be adjusted for use on low-growing crops of different row spacings. Treating booms may be moved horizontally and vertically within rows. This permits the spray nozzles and dust outlets mounted on the booms to be operated at a uniform height above the ground. The result is accurate placement of insecticides on the upper and under parts of plants.

Agricultural engineer Vilas D. Young and entomologist Joseph C. Chamberlin of USDA's Agricultural Research Service, Forest Grove, Oreg., led in development of the equipment. The work was conducted in cooperation with the Oregon, Washington, and Idaho Agricultural Experiment Stations, and with the Washington State Potato Commission.

The unit can be powered by a row-crop tractor or other suitable vehicle. A horizontal tubular drawbar is attached to the vehicle at a right angle to the direction of travel. Trailing spraying-dusting booms are attached by universal joint to the drawbar. The number of trailing booms used depends on the number of rows to be treated at one time.

Atomizing spray nozzles and dust outlets on the trailing booms are guided through rows by a shoe on the lower end of each boom. These shoes are similar to skis. They run on the ground in the furrows midway between rows. The shoes carry the weight of the trailing booms and keep the delivery outlets in a constant position relative to the ground surface.

One set of nozzles and dust outlets is directed to treat under leaves and near the ground level in adjacent rows. Another set of nozzles and dust outlets treats the tops and sides of these same plants.

An additional improvement consists of mounting the atomizing spray nozzles in sleeves attached to the dust outlets. A stream of air or dust under high velocity from the duster fan is sent through the tubes to break up the spray as it leaves the nozzles.

'TO PLANT, OR NOT TO PLANT'—GROWER'S SOLILOQUY

Paraphrasing William Shakespeare, and at the same time giving the finished product a strong, earthy produce flavor, is no small accomplishment. Herewith "Growers Soliloquy," taken from the immortal bard's Hamlet, Act 3, Scene 3, and composed by Sam Beard of S. N. Beard & Co.:

To plant or not to plant—that is the question:—Whether 'tis nobler, after all, to suffer the ups and downs of changing markets, or make plans against a sea of over-production and by opposing, end them?

To plant, to grow no more; or by less acres to say we end the heart-aches and the thousand natural losses that growers are heir to;

'Tis a consummation devoutly to be wish'd.

To plant—to grow—to sell, perchance to consign, Ay, there's the rub: for in those nebulous realms what dreams of net returns may come.

For who would bear the whips and scorns of heavy losses incurred—the pangs of fading bank account—the account sales delay.

The insolance of Nature and the spurns of shippers who pass us by.

To grunt and sweat, under a weary grower's life, to be ever in dread of the bankrupt's morgue.

Or shall one go to that undiscovered country, full of government plans and subsidies, from whose bourne, no traveler returns—this puzzles the will and makes us rather bear those ills we have, than fly to others, we know not of.

Thus, over-production and low markets does make paupers of us all; and all good plans and resolutions are sickened o'er, with no co-operation.

So, enterprises of great pith and moment are made small when markets remain awry and all f. o. b. sales are lost.

Soft you now—a seed man approaches.

Reprinted from The Packer

POLYETHYLENE EXPERTS ANSWER PRODUCE PACKAGING PROBLEMS AT NATIONAL PACKAGING EXPOSITION

Produce industry representatives attending the National Packaging Exposition at Chicago's International Amphitheatre, April 13-17 availed themselves of a unique Technical Information Center on polyethylene film at U. S. Industrial Chemicals Co.'s exhibit. In a departure from normal industry practice of manning such exhibits primarily with sales personnel, U. S. I. offered the services of trained specialists who are well versed in polyethylene technology as it applies to produce applications.

These specialists were on hand to advise converters and users on the proper selection of polyethylene film necessary for a given application. Questions of specific interest to the vegetable and fruit packers such as strength and thicknesses of film in relation to weight of produce packaged, slip, moisture transmission, etc., were answered.

According to Vincent McCarthy, Manager of Polyethylene Sales, consumption of polyethylene film by the produce industry is constantly increasing and, in the opinion of U. S. I., adequate exchange of technical information and good working relationships between resin manufacturer, processor, converter and end user are essential to further expansion of this market.

Features of the Exhibit

Cast polyethylene film of ultra-high clarity and gloss made from U. S. I.'s PETROTHENE* resin were shown in an array of packaged products. Made by a new processing technique, the film is extruded from the die onto a chrome plated chill roll. The casting step greatly improves the see-through clarity and gloss properties of the film, making it especially suitable for applications where the attractive appearance of the packaged product is of prime importance.

*Trademark.

MILLER 658 FUNGICIDE CONTROLS GRAY LEAF SPOT IN MARYLAND TESTS

Miller 658 Fungicide produced one of the top yields on Tomatoes in the 1958 tests for Gray Leaf Spot Control conducted on the Eastern Shore of Maryland by the University of Maryland Experiment Station; these tests were conducted by J. G. Kantzes and C. E. Cox.

Miller 658 Fungicide, the result of many years of intensive research, is one of the most efficient fungicides for the control of Early and Late Blights of potatoes and tomatoes and for the control of certain other diseases on cucurbits, peanuts, citrus fruits, avocados, azaleas and turf. It is a green-yellow, free-flowing powder which is chemically stable and not affected by storage under normal dry conditions. Miller 658 Fungicide is compatible with most commonly used insecticides.

IFT AWARD TO 'POTATO FLAKES'

The Institute of Food Technologists will hail a completely new dehydrated mashed-potato product—potato flakes—at its annual convention in Philadelphia, May 18. The Eastern Utilization Research and Development Division of the USDA's Agricultural Research Service will be recognized for its development of potato flakes by becoming the first recipient of the IFT's Food Technology Industrial Achievement Award. It is appropriate that the honor should be bestowed in Philadelphia, the location of the eastern division where potato flakes originated and were first made on a pliot-plant scale less than five years ago.

The potato-flake process was invented by two chemical engineers, James Cording, Jr., and Miles J. Willard, Jr., and the development was carried out under direction of Roderick K. Eskew, chief of the eastern division's engineering and development laboratory. Plaques will be presented to the men responsible for the achievment in ceremonies at Philadelphia's Bellevue Stratford hotel as part of the convention proceedings.

Big Success

First made commercially only a little more than a year ago, potato flakes have achieved a phenomenal success. Total production this season in the seven U. S plants where flakes are now being made should reach 25 million pounds. Nationwide distribution to the retail and institutional trade is rapidly being approached.

The development has meant a great deal to agriculture, for it has provided potato growers with a new and profitable food outlet for their crops. And the benefit is not limited to those areas of the country where high-solids varieties are grown. The process is adaptable to potatoes of many growing areas.

The flake process is simple. It consists essentially of drying freshly mashed potatoes on a drum dryer such as is used in potato-flour plants. In about 20 seconds, the potatoes come from the dryer in the form of a parchment-like sheet containing 4½ to 5 per cent moisture. An attachment on the dryer cuts the sheet into flakes of the desired size for packaging.

Important Feature

An essential feature of the process is that the potatoes are precooked in water and cooled before they are steam-cooked and riced for application to the drum dryer. These preliminary steps improve the texture of the mash and of the final product when is is converted back into mashed potatoes. They are also the steps that make it possible to produce flakes from many varieties of lower-solids potatoes. The principle of precooking and cooling discovered in the course of this development is not only applicable to flakes, but is important to the entire potato-processing industry as a means of controlling the physical properties of potato products.

The popularity of potato flakes with the busy housewife is not difficult to understand. In a minute or two she can convert the flakes into fluffy mashed potatoes that are the equal of the fresh in flavor, color, and texture. She simply adds hot water and milk to the flakes, plus butter and salt as desired, and whips lightly.

Boost Consumption

The advent of this new product promises to boost potato consumption in this country. For the past 50 years Americans have been eating fewer and fewer potatoes, with frequently disastrous results to growers. One of the main deterrents to a wider consumption of potatoes has been the time and labor involved in preparing them—especially in their most popular form, mashed.

Processed potato products, such as chips, frozen french fries, and dehydrated mashed potato granules have done much in recent years ot reverse the declining trend of potato consumption, and the new potato flakes should do a great deal more to restore the potato to the former place of prominence in the American diet.

—Reprinted from The Packer

EDITORIAL — NATIONAL POTATO COUNCIL NEWS

The following is an editorial by A. E. Mercker, Executive Director of the National Potato Council, from the February-March issue of the National Potato Council News.

What we need is to get the 25,000 growers who plant ten or more acres of potatoes and who produce 90 per cent of the crop to adjust their acreage so that production will be adjusted to the demand. The 1958 crop of 264,000,000 cwt., had a value of $337,000,000 and was enough to feed a population of 210,000,000 persons. The potato growers are out in orbit and circling so that they are now dizzy; so let's land on our feet and make the adjustment that the U. S. Department of Agriculture asks —

A reduction of 16 per cent in the Early States, 8 per cent in the Summer States, 12 per cent in the Fall States.

With yields per acre rising phenomenally and no horizon to yields within sight, a smaller acreage is necessary if profits are to be realized. The 1957 crop of 240,000,000 cwt. was worth $462,000,000; the 1950 crop of 259,000,000 cwt., was worth $394,00,000; whereas the 1952 crop of 211,000,000 cwt., was worth $585,000,000. The reduction is only moderately less than the acreage of 1,498,000 acres planted in 1958 and only 100,000 acres less than that planted in 1957.

The United States guide acreage of 1,323,000 acres is enough to produce 230,000,000 cwt., which is sufficient for all food requirements either for fresh use or processing, for seed, waste and export.

The production of 230,000,000 cwt., is 6 per cent larger than the 1958 marketing guide, and reflects the increased use of potatoes due to the annual gain in population. In addition, allowance was made for possible improvement in the appearance and quality of shipments to the fresh market, necessitating more rigid culling.

Therefore, to make potato production *profitable* it is necessary to reduce the acreage in line with the recommendations of the U. S. Department of Agriculture.

—Reprinted from Red River Valley Potato Growers Assn. News.

"The ORTHO program this year helped me increase my yields by an average of 20 bags (potatoes) per acre,"

states Mr. Guy Lockerman, owner and manager, Sunset View Farms, Middletown, Delaware.

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ERRATA — MARCH 1959 ISSUE

With reference to the article by Folsom and Friedman, "Pseudomonas fluorescens in relation to certain diseases of potato tubers in Maine," the following corrections should be made:

p. 90 line 8 spelling should be stolon —
p. 90 line 13 substitute practically for particularly —
p. 91 insert under figures 1-10. Figure 4—Discolored xylem in tangential section of tuber.
p. 96 line 3 should read *P. xanthochlora* (Schuster) —
p. 97 reference 11 volume and number should read 3 (1)
p. 97 reference 24, pages should read 592-532.

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- ***Improves quality** . . . by supplying needed trace elements.
- ***Safe to use** . . . no residual tolerance restrictions on harvested crops.
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*REG. T.M.

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Tests during 1958 in major potato states compared the blight controlling ability of DITHANE M-22 and of nabam. Late blight was severe in two of the states; early blight in one.

The conclusions reached by the scientists confirm the results obtained by the many growers who also compared the performance of DITHANE M-22 and nabam.

At intervals of seven days, DITHANE M-22 (1½ pounds/acre) gave better control of late blight than DITHANE D-14 (2 quarts/acre). At intervals of ten days the superiority of DITHANE M-22 was outstanding. Similar advantages in early blight control with DITHANE M-22 were noted.

Yields were significantly higher where better blight control was obtained with DITHANE M-22. In the plots protected at 7-day intervals, DITHANE M-22 outyielded DITHANE D-14 from 20 to 70 bushels per acre.

These facts prove that DITHANE M-22 is superior to nabam in controlling early and late blight. Equally important, DITHANE M-22 gives you standby *protection*—protection to carry your vines safely past emergencies when the interval between sprays must be lengthened. We think you will find DITHANE M-22 truly a milestone in potato blight control.

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